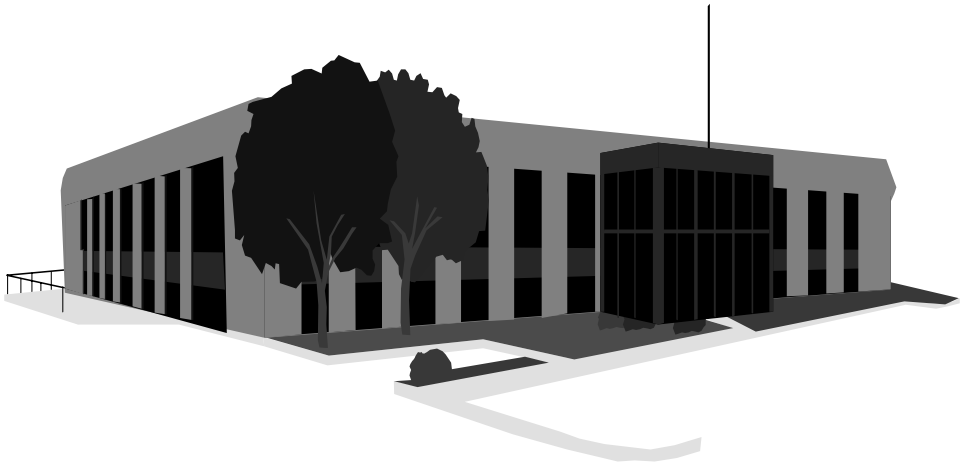
INDOOR AIR QUALITY ASSESSMENT

Sullivan Middle School
150 Draper Street
Lowell, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
February, 2001

Background/Introduction

At the request of the Lowell Health Department, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) was asked to provide assistance and consultation regarding indoor air quality and health concerns at the Sullivan Middle School in Lowell, Massachusetts. On October 18, 2000 Cory Holmes, Environmental Analyst of the Emergency Response/Indoor Air Quality (ER/IAQ) Program and Suzan Donahue, Research Assistant, ER/IAQ conducted an indoor air quality assessment.

The school is a two-story brick building built in 1992. Four modular classrooms were added in 1998. The second floor consists mostly of general classrooms and a library. The first floor contains general classrooms, art rooms, offices, auditorium, music/band rooms, technical education/wood shop, gymnasium and cafeteria.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model No. 8551.

Results

The school houses grades five through eight with a student population of approximately 720 and a staff of 100. The tests were taken under normal operating conditions. Test results appear in Tables 1-7.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in thirty-seven of forty-six areas surveyed, indicating an overall ventilation problem in the school. It should be noted that many rooms had open windows/doors during the assessment, which can greatly contribute to reduced carbon dioxide levels. Twenty classrooms measured above 800 ppm with open windows, which indicates little air exchange in these rooms. Of note were the modular classrooms, all of which had carbon dioxide levels in excess of 2,000 ppm. Elevated carbon dioxide levels were also measured in the auditorium at full capacity during an assembly.

Fresh air in most classrooms is supplied by a unit ventilator (univent) system (see Picture 1) controlled by a computer-pneumatic interface system. This system is controlled electronically from an off-site location. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 2) and return air through an air intake located at the base of each unit. The mixture of fresh and return air is drawn through a filter and a heating/cooling coil, and is then provided to classrooms from the univent by motorized fans through fresh air diffusers located at the top of the unit (see Figure 1).

Univents were deactivated in a number of classrooms (see Tables) by control systems within each unit. BEHA staff and school maintenance personnel re-activated several of these units to ensure they were operable. The univents appeared operable, however it was reported that as a result of temperature fluctuations, classroom occupants have deactivated or requested that their classroom univents be deactivated. Without univents operating, the HVAC system does not function as designed, preventing fresh outside air from being distributed to classrooms. Obstructions to airflow, such as books,

papers and posters on top of univents, and bookcases, tables and desks in front of univent returns were also seen in a number of classrooms (see Pictures 1 & 3). To function as designed, univent fresh air diffusers and return vents must remain free of obstructions. It is important that these units be activated and allowed to operate during school hours.

The mechanical exhaust ventilation system consists of ceiling-mounted exhaust vents. Exhaust vents were not drawing air in a number of classrooms, which can indicate that exhaust ventilation was turned off, or that rooftop motors were not functioning. In some classrooms, the exhaust vent is located above the classroom door. The location of these exhaust vents can limit exhaust efficiency when the classroom door is open (see Picture 4). When a classroom door is open, exhaust vents will tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms. With decreased function of exhaust vents, normally occurring environmental pollutants can build up and lead to indoor air quality and comfort complaints. In addition a number of exhaust vent louvers appeared closed (see Picture 5).

Ventilation for modular classrooms, core rooms and common areas is provided by ducted air handling units (AHUs) located on the roof or in mechanical rooms (see Pictures 6 & 7). Each modular classroom has its own AHU. Fresh air is distributed via ductwork connected to ceiling-mounted air diffusers. The amount of fresh air drawn into the units is controlled by moveable louvers connected to an activator motor that adjusts to alter fresh air intake. Return vents draw air back to the units through wall or ceiling-mounted grilles. Thermostats control each heating, ventilating and air conditioning (HVAC) system (see Picture 8). In modular classrooms, thermostats have settings of "on" and "automatic". Thermostats were set to the "automatic" setting in all of the modular rooms surveyed during the assessment. The automatic setting on the thermostat

activates the HVAC system at a pre-set temperature. Once a pre-set temperature is measured by the thermostat, the HVAC system is deactivated. Therefore no mechanical ventilation is provided until the thermostat re-activates the system.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 69° F to 79 ° F, which were within or very close to the BEHA recommended range in all areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. Although temperatures were within BEHA guidelines on the day of the assessment, a number of temperature control complaints were expressed to BEHA staff. It is difficult to control temperature and maintain comfort without operating the HVAC equipment as designed. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was within the BEHA recommended comfort range in most areas sampled. Relative humidity measurements ranged from 43 to 53 percent, with two exceptions: the auditorium at full capacity measured 64 percent, and the library headroom (221) containing a computer mainframe measured 39 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

During periods of high relative humidity (late spring/summer months), windows and exterior doors should be closed to keep moisture out when the air conditioning system is activated. In addition, all HVAC equipment (i.e. HVAC units and univents) should be activated during summer months to dilute and/or remove moist air in the building. The combination of deactivated ventilation systems and open exterior doors and windows can cause relative humidity levels to become elevated indoors. While temperature is mainly a comfort issue, relative humidity in excess of 70 percent can provide an environment for mold and fungal growth (ASHRAE, 1989).

Microbial/Moisture Concerns

Stained ceiling tiles were observed in some areas (see Picture 9). Water-damaged ceiling tiles can provide a source of mold and mildew and should be replaced after a water leak is discovered. A few areas had plants (see Tables). Plant soil and drip pans can serve as source of mold growth. A number of plants did not have drip pans. The library had plants on the carpet. Classroom 210 had a plant on the univent. The lack of drip pans and/or over-watering can lead to water pooling and mold growth on porous materials (e.g. carpeting). Plants should be properly maintained and be equipped with drip pans. Plants should also be located away from the air stream of mechanical ventilation to prevent aerosolization of dirt, pollen or mold.

Many areas of the school are carpeted. In some areas, carpeting was stained/rippled, indicating possible water damage. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that carpeting be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If carpets are not dried within this time frame, mold growth may occur. Once mold has colonized porous materials, they are difficult to clean and should be removed.

Spaces between the sink countertop and backsplash were seen in some areas (e.g. room 205). Improper drainage or overflow could lead to water penetration of countertop wood, the cabinet interior and behind cabinets. Like other porous materials, if these materials become wet repeatedly they can provide a medium for mold growth, which is difficult to clean and can be irritating to sensitive individuals.

Other Concerns

Several other conditions were noted during the assessment, which can affect indoor air quality. Cleaning products were found on counter-tops and beneath sinks in a number of classrooms. Cleaning products contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

The main office and teachers' lounges have photocopiers. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). School personnel should ensure that local exhaust ventilation is activated while equipment is in use to help reduce excess heat and odors in these areas.

The wood-shop is not equipped with a wood dust collection system. There are wood cutting/sanding machines and a grinding machine in the shop (see Picture 10). As grinding machines grind or cut metal, heated metal particles (called fume) is produced and aerosolized. Wood dust and metal fumes are respiratory irritants. These machines should be equipped with local exhaust ventilation to prevent the aerosolization of wood dust and particulate matter.

Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, (e.g. methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be

irritating to the eyes, nose and throat. Accumulated chalk dust was noted in several classrooms (see Picture 11). Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several areas had missing ceiling tiles (see Picture 12). Missing ceiling tiles can provide an egress for dirt, dust and particulate matter into occupied areas. These materials can also be irritating for certain individuals.

The school's dumpster is located behind the building. Although no reports of trash odors were reported, the close proximity of the dumpster to the building may provide for nuisance odors to enter classrooms through the univent fresh air intake (see Picture 13) or by open windows during the Spring and Summer months.

Pottery items were noted drying on top of the univent in art room 141. Accumulated dirt/dust/pottery debris was also noted within the interior of the univent. Clay dust is a fine particulate that can be easily aerosolized and distributed by the air stream of the univent diffuser. Accumulated dirt/dust/debris was also noted in several other classroom univents. Room 142 contained a kiln. The local exhaust hood over the kiln was examined and was not functional during the assessment (see Picture 14). Kiln exhaust may contain corrosive, hazardous and irritating materials including chlorine, sulfur dioxide and carbon monoxide, and should be provided with dedicated local exhaust ventilation (McCann, 1985). Without local exhaust ventilation, pollutants produced by the pottery kiln can penetrate into adjacent areas of the school.

Conclusions/Recommendations

The symptoms reported at the Sullivan Middle School (e.g., temperature complaints, eye/throat irritation) are consistent with what would be expected based on the conditions in the building observed during the assessment. The deactivation of ventilation systems in combination with the build-up of normally occurring

environmental contaminants (e.g. household dust, carbon dioxide, office equipment) has lead to complaints of poor indoor air quality. In view of the findings at the time of the inspection, the following recommendations are made:

1. Develop a clear line of communication between the central maintenance department and school personnel for prompt remediation of temperature and/or ventilation concerns/complaints. This can be done by establishing a written request system administered by a single responsible person. Classroom occupants should report temperature extremes immediately to school administration/maintenance and refrain from deactivating equipment.
2. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
3. Examine each AHU and univent and for proper function. Survey equipment to ascertain if an adequate air supply exists for each area serviced. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the maintenance and calibration of HVAC equipment and univent fresh air control dampers school-wide.

4. Inspect exhaust motors and belts for proper function, repair and replace as necessary.
5. Close classroom doors to maximize exhaust ventilation. Ensure louvers to classroom exhaust vents are open to facilitate airflow.
6. Remove all blockages from univents to ensure adequate airflow. Clean out interiors of univents regularly.
7. Once both the fresh air supply and the exhaust ventilation are functioning properly, the system should be balanced by an HVAC engineer.
8. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
9. Repair and/or replace thermostats as necessary to maintain control of comfort.
10. Ensure plants have drip pans, examine drip pans for mold growth and disinfect areas with an appropriate antimicrobial where necessary. Keep plants away from univents in classrooms.
11. Replace any water-damaged ceiling tiles, insulation and building materials. Examine the areas above and around these areas for mold growth. Repair water leaks and disinfect areas of water leakage with an appropriate antimicrobial if necessary.
12. Seal areas around sink in classrooms, to prevent water-damage to the interior of cabinets and adjacent wallboard. Inspect wallboard for water-damage and

mold/mildew growth, repair/replace as necessary. Disinfect areas of microbial growth with an appropriate antimicrobial as needed.

13. Examine carpeting for water damage and remove/replace if moldy. Disinfect areas of floor underneath water-damaged carpeting with an appropriate antimicrobial.
14. Store cleaning products and chemicals properly and keep out of reach of students.
15. Ensure exhaust ventilation is functioning in areas that contain photocopiers.
16. Refrain from using strong scented materials in classrooms and restrooms.
17. Ensure aquariums are properly cleaned to prevent odors and/or algae growth.
18. Replace missing ceiling tiles to prevent the egress of dirt, dust and particulate matter into occupied areas.
19. Consider discontinuing the use of the kiln until local exhaust ventilation system is repaired/reactivated.

References

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Picture 1

univent return vent

Classroom Univent - Note Return Vent on front of Unit Blocked by Sheet

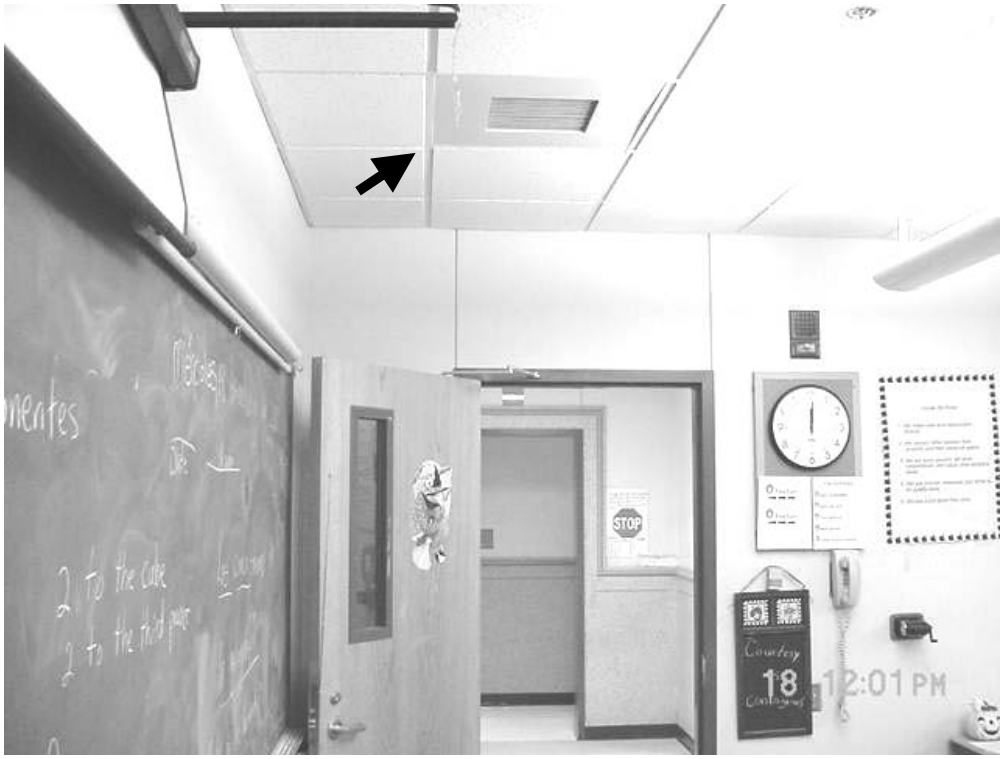
Picture 2

Univent Fresh Air Intakes on Exterior of School

Picture 3

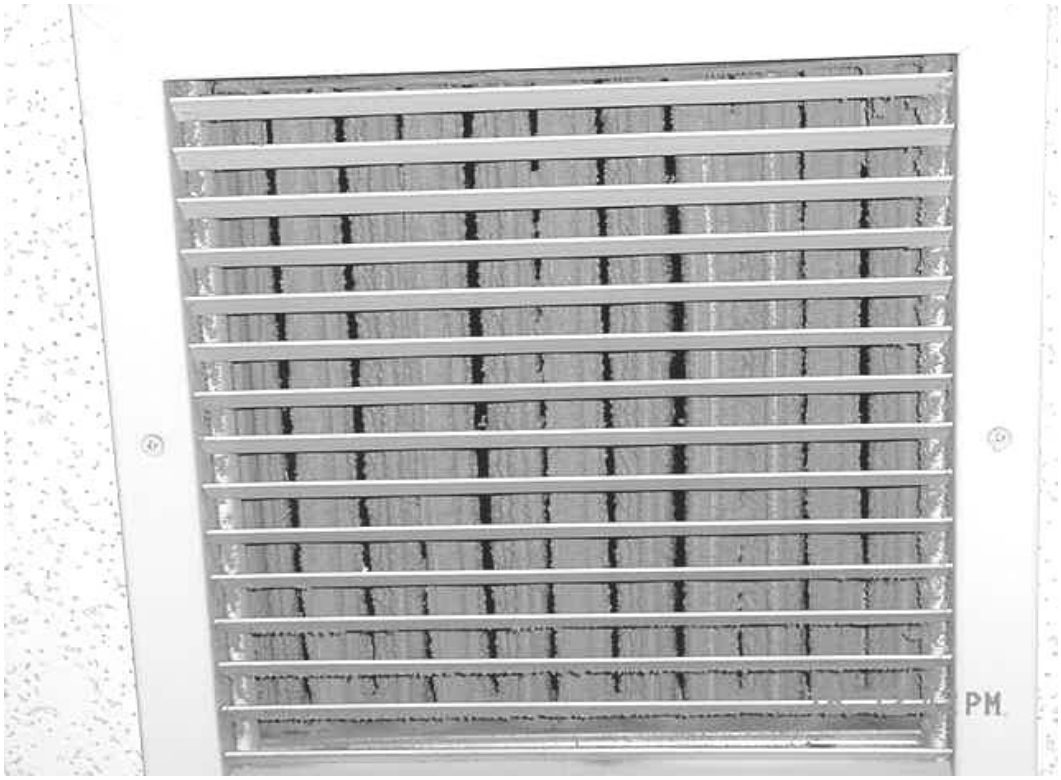
Univent Air Diffuser Obstructed by Storage Boxes

Picture 4



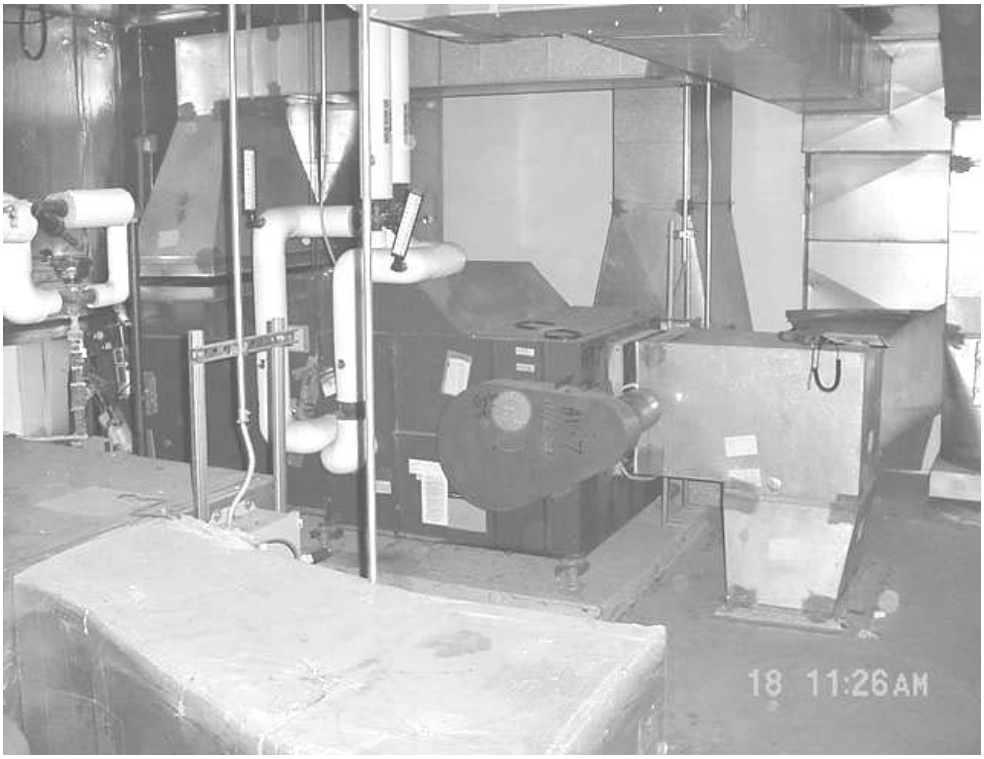
Classroom Exhaust Vent - Note Classroom Door open to the Hallway

Picture 5



Classroom Exhaust Vent - Note Louvers Appear Closed, Restricting Airflow

Picture 6



Air Handling Unit Located in Second Floor Mechanical Room

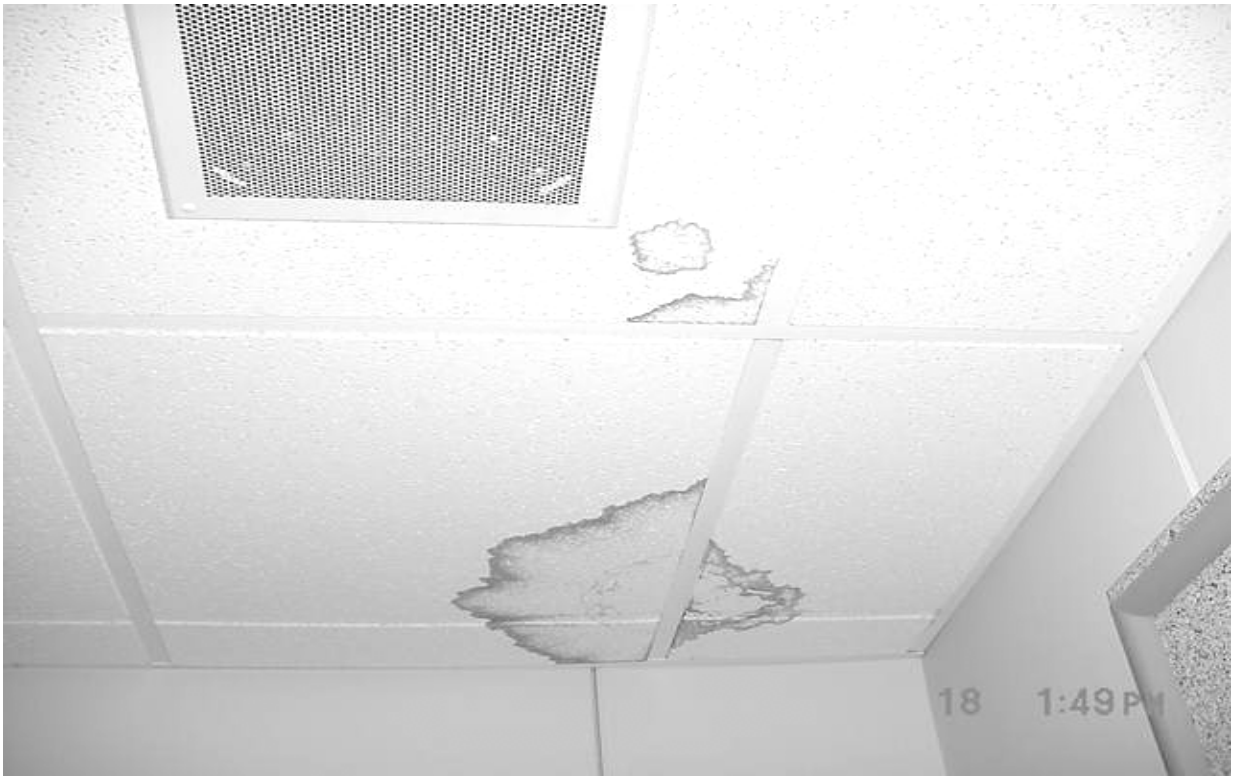
Picture 7

Rooftop Air Handling Units for Modular Classrooms

Picture 8

Close-up of Modular Classroom Thermostat - Note Thermostat Set to “Auto” Position

Picture 9

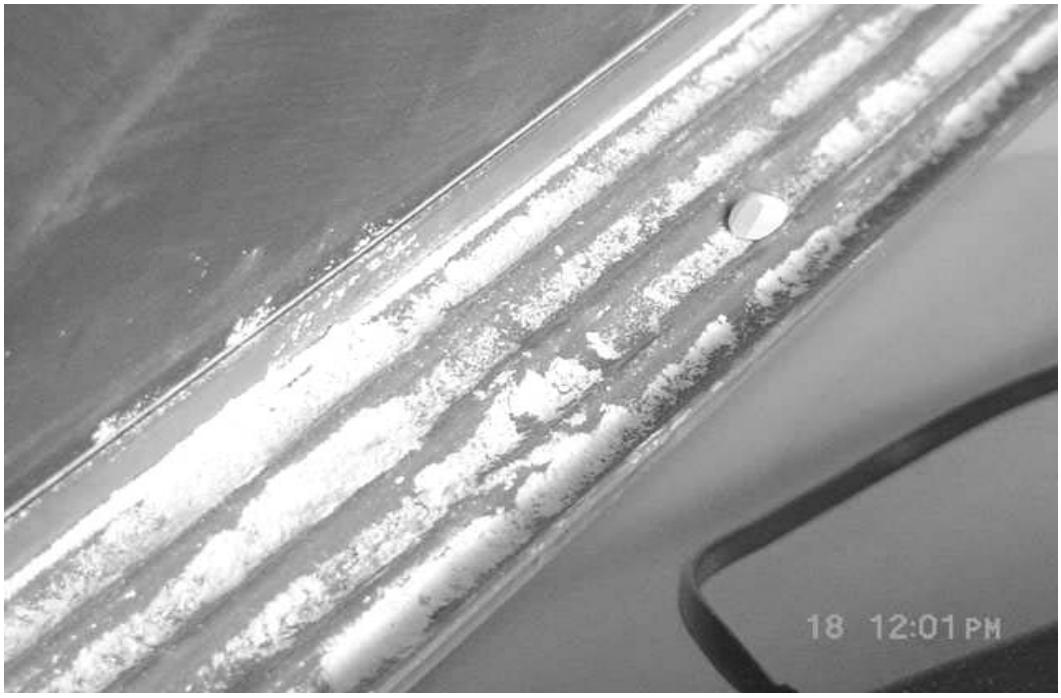


Stained Ceiling Tiles in Modular Classroom

Picture 10

Unvented Grinding Machine in Wood Shop

Picture 11



Accumulated Chalk Dust in Classroom

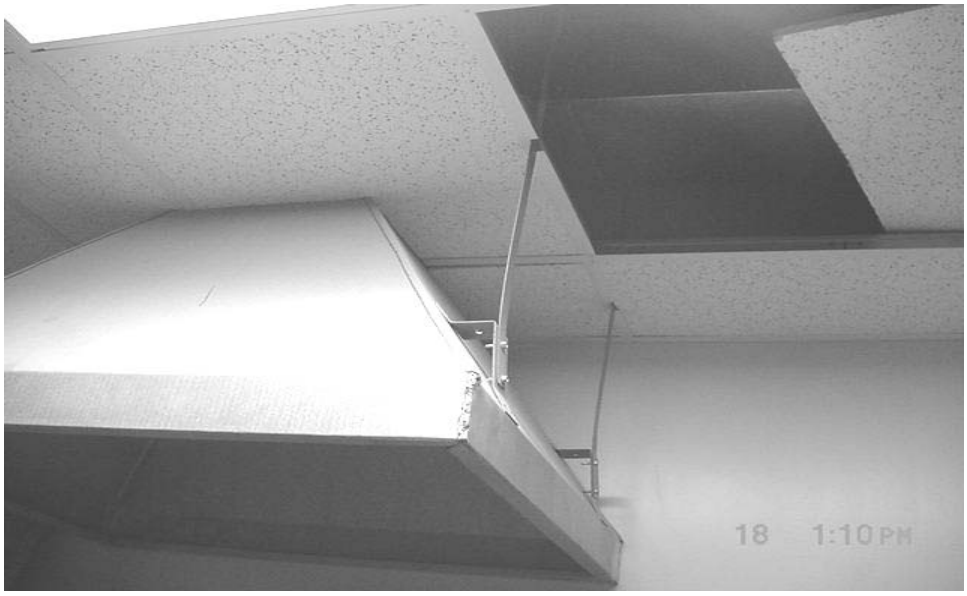
Picture 12

Missing Ceiling Tiles

Picture 13

Dumpster Located below Univent Fresh Air Intake
Note Trash Piled on Top of Dumpster

Picture 14



Local Exhaust Hood for Pottery Kiln
Note Vent Hood was Non-Functional During the Assessment

TABLE 1

Indoor Air Test Results –Sullivan Middle School, Lowell, MA – October 18, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	463	59	62					Weather conditions: overcast
Theater	2180	69	64	~100	No	Yes	Yes	Full auditorium-assembly
Classroom 206	833	72	49	1	No	Yes	Yes	Temperature complaints-cold
Classroom 208	969	74	47	2	No	Yes	Yes	
Classroom 210	900	76	43	0	Yes	Yes	Yes	Univent off (activated), flowering plants, window open
Classroom 212				0	Yes	Yes	Yes	Stained ceiling tile-painted, window open
Classroom 224	1054	76	45	23	Yes	Yes	Yes	Univent off, exhaust off (activated) Window open
2nd floor Boys' Restroom							Yes	Exhaust off
Classroom 214	1245	77	46	29	Yes	Yes	Yes	Window open, univent and exhaust off
Theater	790	71	46	1	No	Yes	Yes	Ceiling mounted vents, exhaust vents located on side of stage and rear of auditorium, carpeted,

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results –Sullivan Middle School, Lowell, MA – October 18, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
								curtains, used as classroom
Classroom 102	918	73	47	18	Yes	Yes	Yes	Univent off-items on top, exhaust off, window and door open
Phone Room							Yes	Exhaust vent closed
Classroom 108	1074	73	49	9	No	Yes	Yes	Door open, cleaning product odor
Classroom 110	1375	74	51	18	Yes	Yes	Yes	Univent off, exhaust off-louvers appear closed, door open
Classroom 112	1431	75	49	24	Yes	Yes	Yes	Window and door open, univent and exhaust off
Classroom 114		74	44	2	No	Yes	Yes	Door open
Gym	573	72	45	19	No	Yes	Yes	Exhaust off
Boys' Locker room Restroom					No			Missing ceiling tile
Boys' Locker room					No	Yes	Yes	Broken shower-running
Classroom 145	2083	74	50	27	Yes	Yes	Yes	Ventilation off, thermostat on "auto"

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Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results –Sullivan Middle School, Lowell, MA – October 18, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Classroom 142	1392	77	47	23	Yes	Yes	Yes	Window open, thermostat on "auto"
Faculty Restroom							Yes	Exhaust off
Faculty Restroom Hallway								5 CT
Classroom 205	1820	72	53	18	Yes	Yes	Yes	Univent fan and exhaust off, window open, spaces around sink, flickering lights
Girls' Restroom 2nd floor							Yes (2)	Floor drain
Classroom 211	950	73	47	2	Yes	Yes	Yes	Univent fan and exhaust off, rippled carpet
Library	850	74	46	~30	Yes	Yes (2)	Yes (2)	Univents and exhausts off, chair on univent, ~24 computers, plants on carpet, door open
Library Office	639	73	44	1	Yes	No	Yes	Window and door open
Library Headroom (221)	668	72	39	0	No	No	Yes	Computer main frame, ceiling tile ajar, dry erase board, door open, storage

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Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results –Sullivan Middle School, Lowell, MA – October 18, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Library Workroom	676	73	44	0	No	Yes	Yes	Coffee odor, sink
Teachers' Room (229)	788	73	45	7	Yes	Yes (2)	Yes (2)	Sink, soda machine, carpet, reported allergies
Teachers' Room (227)	574	74	44	0	No	Yes	Yes	
Classroom 201	800	76	44	17	Yes	Yes	Yes	Exhaust off, univent return blocked/items on top, dry erase board, (4)buckets of water/sponges, door open, snacks, personal fan, missing ceiling tile
Classroom 203	851	76	43	17	Yes	Yes	Yes	Exhaust off, personal fan, dry erase board
Classroom 213	953	75	44	24	Yes	Yes	Yes	Univent and exhaust off, accumulated debris in univent, chalk dust, window open
Classroom 215	940	76	46	26	Yes	Yes	Yes	Exhaust off, window and door open, missing ceiling tile, stained carpet
Girls' Restroom (near library)							Yes (2)	Exhaust off

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Comfort Guidelines

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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results –Sullivan Middle School, Lowell, MA – October 18, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Classroom 210	1317	79	47	22	Yes	Yes	Yes	Exhaust off, plants on univent, window and door open
Classroom 204	1372	79	45	27	Yes	Yes	Yes	Exhaust off, univent blocked, missing ceiling tile, chalk dust
Classroom 202	1240	77	43	24	Yes	Yes	Yes	Window and door open, dry erase board, missing ceiling tile, food crumbs on carpet
Woodshop	1137	74	43	0	Yes	Yes	Yes (3)	Univent and exhaust off, no wood dust collection system, window mounted exhaust fan, grinding machine, non-flammables in flammables cabinet
Teachers' Room (119)	967	75	45	9	Yes	Yes (2)	Yes (2)	1 out of 2 exhaust vents off, sink, stained carpet, vending machine on carpet, recyclables in cardboard box
Teachers' Room (117)	886	75	44	0	No	Yes	Yes	2 photocopiers, carpet
Cafeteria	1270	76	48	~100	Yes	Yes (14)	Yes (6)	Window and door open
Classroom 125	1638	76	46	12	Yes	Yes	Yes	Univent and exhaust off, stained/rippled carpet,

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Relative Humidity -	40 - 60%

TABLE 6

Indoor Air Test Results –Sullivan Middle School, Lowell, MA – October 18, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
								~6 computers, chalk dust
Classroom 127	747	73	46	18	Yes	Yes	Yes	Univent off, window open, rippled carpet, dry erase board cleaner
Classroom 141 (Art Room)	1035	73	46	18	Yes	Yes	Yes	Univent off, clay item drying on univent, 1 CT, window open, lamination machine, (abandoned) darkroom-exhaust on, flickering light
Classroom 140 (Art Room)	1528	74	47	19	Yes	Yes	Yes	Univent off-debris in univent
Room 142 (Kiln Room)								Vented kiln-not operational, capped septic tank
Girls' Locker Room						Yes	Yes	Supply off, restroom exhaust off
Classroom 144	2440	76	52	24	Yes	Yes	Yes	Supply and exhaust off-louvers closed, dry erase board
Classroom 143	3154	77	53	21	Yes	Yes	Yes	Supply and exhaust off, dry erase board, thermostat set to "auto"
Classroom 228	953	75	44	19	Yes	Yes	Yes	Univent off, window open

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TABLE 7

Indoor Air Test Results –Sullivan Middle School, Lowell, MA – October 18, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Classroom 239	1128	76	44	27	Yes	Yes (2)	Yes (3)	Window open, 5 plants
Classroom 235	807	75	43	18	Yes	Yes	Yes	Window and door open, plant
Classroom 233	1006	77	45	17	Yes	Yes	Yes	Window and door open, univent off-stuffed animals on top
Classroom 231	951	74	44	4	Yes	Yes	Yes	Univent off, window open
Music Room	1576	74	48	21	Yes	Yes (2)	Yes	Univents off-keyboards on top, exhaust off, window open, 3 plants
Main Office-Reception Area	984	73	43	3	No	Yes	Yes	Door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%